51. IWK

Internationales Wissenschaftliches Kolloquium
International Scientific Colloquium

PROCEEDINGS 11-15 September 2006

FACULTY OF ELECTRICAL ENGINEERING AND INFORMATION SCIENCE

INFORMATION TECHNOLOGY AND ELECTRICAL ENGINEERING - DEVICES AND SYSTEMS, MATERIALS AND TECHNOLOGIES FOR THE FUTURE

Startseite / Index:
http://www.db-thueringen.de/servlets/DocumentServlet?id=12391

TECHNISCHE UNIVERSITÄT
ILMENAU

Impressum

Herausgeber: Der Rektor der Technischen Universität Ilmenau
Univ.-Prof. Dr. rer. nat. habil. Peter Scharff

Redaktion: Referat Marketing und Studentische Angelegenheiten
Andrea Schneider

Fakultät für Elektrotechnik und Informationstechnik
Susanne Jakob
Dipl.-Ing. Helge Drumm

Redaktionsschluss: 07. Juli 2006

Technische Realisierung (CD-Rom-Ausgabe):
Institut für Medientechnik an der TU Ilmenau
Dipl.-Ing. Christian Weigel
Dipl.-Ing. Marco Albrecht
Dipl.-Ing. Helge Drumm

Technische Realisierung (Online-Ausgabe):
Universitätsbibliothek Ilmenau
ilmedia
Postfach 10 05 65
98684 Ilmenau

Verlag:
Verlag ISLE, Betriebsstätte des ISLE e.V.
Werner-von-Siemens-Str. 16
98693 Ilrnenau

ISBN (Druckausgabe): 3-938843-15-2
ISBN (CD-Rom-Ausgabe): 3-938843-16-0

Startseite / Index:
http://www.db-thueringen.de/servlets/DocumentServlet?id=12391

51st Internationales Wissenschaftliches Kolloquium
Technische Universität Ilmenau
September 11 – 15, 2006

D. Solomakho, V. Minchenya

Application Of Noncontact Inductive Sensors For The Purpose Of Flexible Thrombolysis Waveguides Acoustic Parameters Control

ELECTRICAL AND MAGNETIC SENSORS AND ACTUATORS

INTRODUCTION

Ultrasonic destruction of thrombus is widely used in modern cardiology [1]. For this purpose flexible waveguides with the length of more than 500 mm and diameter of the effective part not more than 1,8 mm and the resonance frequency 24-30 kHz are used. The major destructive mechanisms in this case are cavitation damage, acoustic streaming and contact effect on thrombus and thromboembols [2].

Insufficient vibration amplitude leads to the increase of exertion applied to the instrument by the surgeon, which can cause the perforation of the vessel wall. Superfluous amplitude leads to the thermal injury and postoperative thrombosis.

In order to increase the effectiveness of ultrasonic thrombus destruction it is necessary to control amplitude and frequency of flexible waveguide vibration, which enables to manipulate these parameters and set an optimal mode of functioning.

1 INSTRUMENTATION

A noncontact amplitude and frequency sensor for flexible waveguides vibration parameters measurement was developed in Belarusian National Technical University. The sensor consists of eight noncontact inductive transducers, four of which are used for measuring and the other – for compensational purposes. The sensor registers parameters caused by the propagation of ultrasound along the waveguide only and does not detect the signal, caused by the displacement of the waveguide in the plane of registration. This is caused by the fact that total inductance of four measuring transducers equals to zero in any position of the waveguide and the measurement signal is caused by the alteration of the waveguide linear dimensions which occurs under the influence of the ultrasonic wave.

As it is known, in rod vibrating systems a functional dependence between amplitudes of displacement in different parts of the waveguide exists. Coefficient of the progressive wave and the length of the acoustic system elements exert influence upon this dependance. These circumstances allow to measure the amplitude and frequency in distance from the end of the effective part of the waveguide having graduated It previousely. Developed sensor registrates the alteration of the transversal dimensions of the waveguide caused by the longitudinal vibrations. Maximum sensitivity can be achieved if the sensor is placed in the oscillating loop.

A chart of the acoustic system with noncontact amplitude and frequency sensor is presented in Fig. 1.

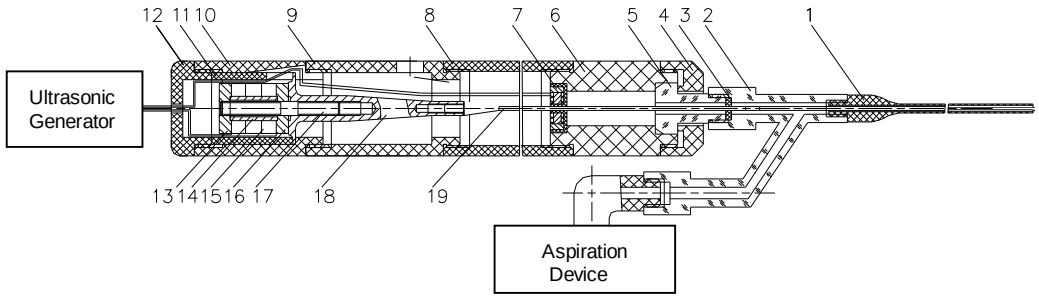

Fig. 1. Acoustic system with noncontact amplitude and frequency sensor.

As shown on the chart, noncontact inductive transducers are built into the case of the thrombus destruction apparatus handle. The acoustic system consists of piezoelectric converter hold-down 1, acoustic uncoupling bush 2, connector bracing screw 3, waveguide tuner elements 4,5,7, acoustic system case 6, ultrasonic converter 8, connector 9, flexible waveguide 10, noncontact sensing element for amplitude and frequency sensor 11.

2 RESULTS AND DISCUSSION

System functioning study shows that results of pure longitudal vibration amplitude measurement correspond to the amplitude of effective part end displacement. Functional dependance between the meterage and the amplitude of effective part end displacement during the alteration of the resonance frequency within ± 3 kHz remains close to linear.

The implementation of this system allows to control the frequency parameters of the

thrombolysis process. In other words, it allows to organise a feedback channel in the “surgeon – patient” system (Fig. 2).

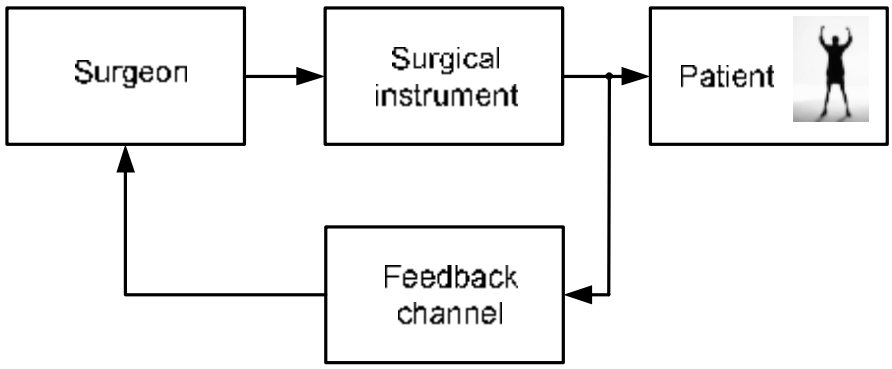

Fig. 2. A diagram of the “surgeon – patient” system with a feedback channel

Ultrasonic vibration frequency in case of ultrasonic thrombolysis depends on the physical properties of the thrombus material: density, viscosity etc. When the effective part of the waveguide contacts the thrombus body, the ultrasound frequency changes, which can be detected by the inductive sensor. The signal from the sensor in this case obtains higher order harmonics, which can be analysed with the help of a spectrum analyzer.

Similar effects may be observed in case the waveguided is bent. Experiments show that if the effective part of the waveguide is bent to an angle not more that 50º the amplitude decreases by approximately 30% and the resonance frequency alteres by approximately 500 Hz. The amplitude decrease is connected above all with the extra energy dissipation in consequence of waveguide material strain.

Amplitude and frequency of the process can be controlled by the surgeon and changed if necessary in accordance to the information from the feedback channel and the quality of the whole process can be improved in this way.

References:

[1] S.L.Ovsianko, E.A. Chernyavsky, V.T.Minchenya, I.E. Adzerikho, V.M. Shkumatov. Effect of ultrasound on activation of serine proteases precursors. Ultrason Sonochem. 2005 Feb;12(3):219-23.
[2] Tun Tzjai, V.T.Minchenya, T.Vladimirskuya, A.G. Mrochek. Progress on Research of Ulrasound angioplasty. Journal of Chinese medicine research Volume 5, Number 2,February, 2005. C.135-136

Authors:

D. Solomakho
Dr. V. Minchenya
Belarusian National Technical University, pr. Nezavisimosti, 65.
220013, Minsk
Phone: +375296537065 E-mail: dimadrol@tut.by